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H04R 1/086; H04R 1/03; H04R 19/04;  
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379/419, 424, 428.01, 433, 433.01,  
379/433.03, 434; 455/575.1

See application file for complete search history.

- (56)
- References Cited**

- U.S. PATENT DOCUMENTS

- |           |   |         |          |
|-----------|---|---------|----------|
| 4,450,930 | A | 5/1984  | Killion  |
| 5,832,079 | A | 11/1998 | Rabe     |
| 5,915,015 | A | 6/1999  | Thornton |

- (Continued)

- FOREIGN PATENT DOCUMENTS

- |    |          |    |        |
|----|----------|----|--------|
| DE | 10201312 | A1 | 2/2003 |
| EP | 0275996  | A2 | 7/1988 |

- (Continued)

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### Related U.S. Application Data

- (63) Continuation of application No. 13/324,511, filed on Dec. 13, 2011, now Pat. No. 8,548,185, which is a continuation of application No. 12/464,727, filed on May 12, 2009, now Pat. No. 8,094,856, which is a continuation of application No. 10/989,071, filed on Nov. 16, 2004, now Pat. No. 7,548,628.

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*H04R 1/02* (2006.01)  
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(2013.01); **H04R 1/083** (2013.01)

## ABSTRACT

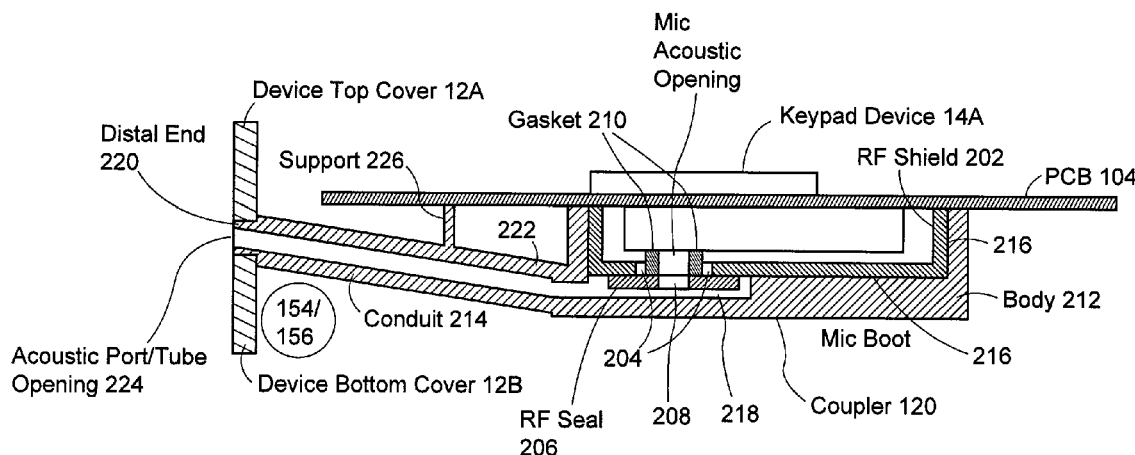
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(57)

The disclosure relates to a mobile communication device. The device comprises: a housing including a housing port; a microphone in the housing; circuitry in the housing and connected to the microphone; a coupler including an acoustic conduit having a first end in communication with the housing port and a second end, and a body section associated with the microphone and in communication with the second end of the acoustic conduit; and a support to brace the coupler in the housing.

**18 Claims, 5 Drawing Sheets**



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6,470,176 B1 10/2002 Mendolia et al.

2002/0106091 A1\* 8/2002 Furst et al. .... 381/335

2004/0203494 A1\* 10/2004 Eaton ..... 455/575.1

(56)

## References Cited

## FOREIGN PATENT DOCUMENTS

## U.S. PATENT DOCUMENTS

6,038,328 A \* 3/2000 Hsu ..... 381/355  
6,108,416 A 8/2000 Collin et al.

EP 1039779 A2 9/2000  
WO WO 2006/024134 A 3/2006

\* cited by examiner

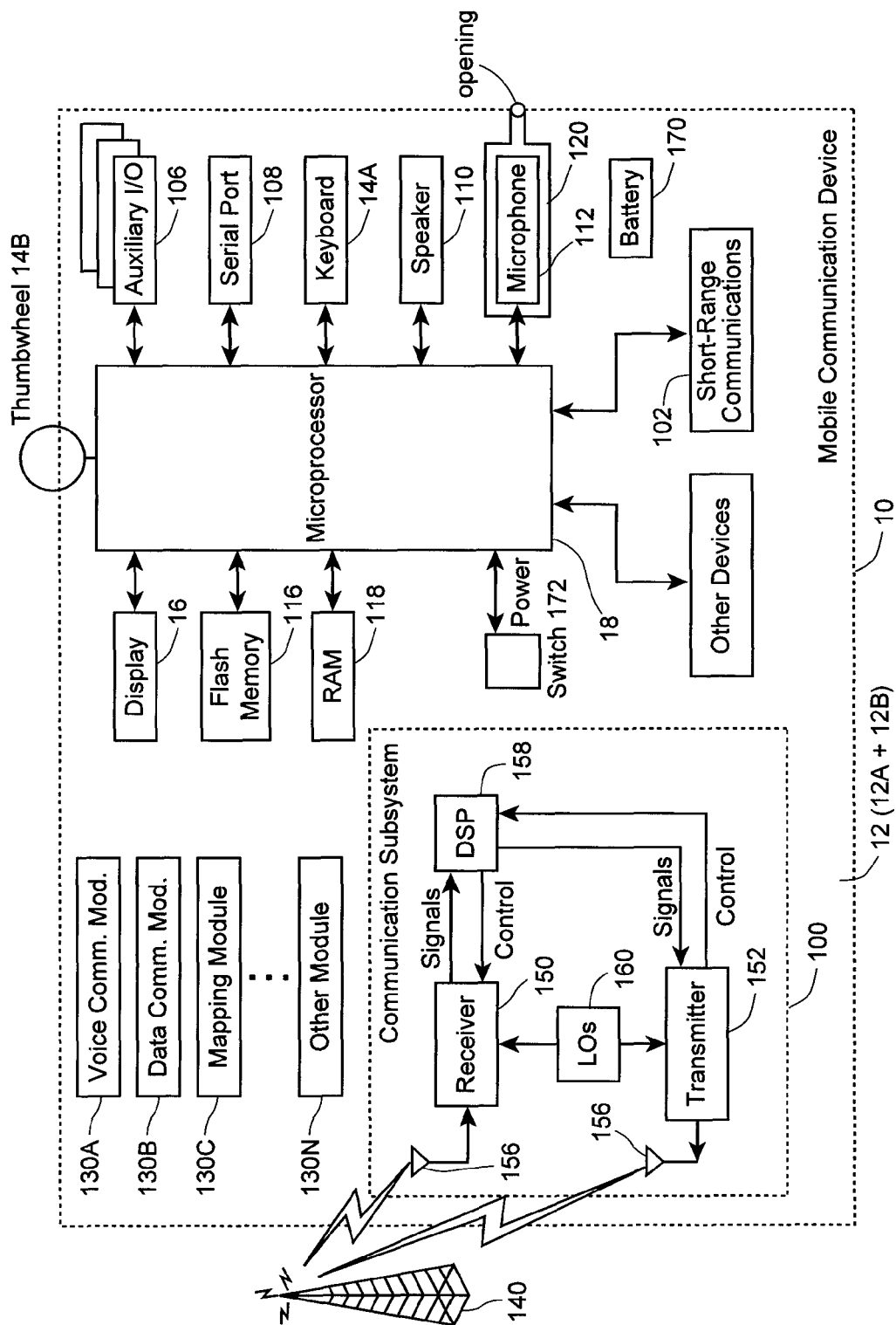


Figure 1

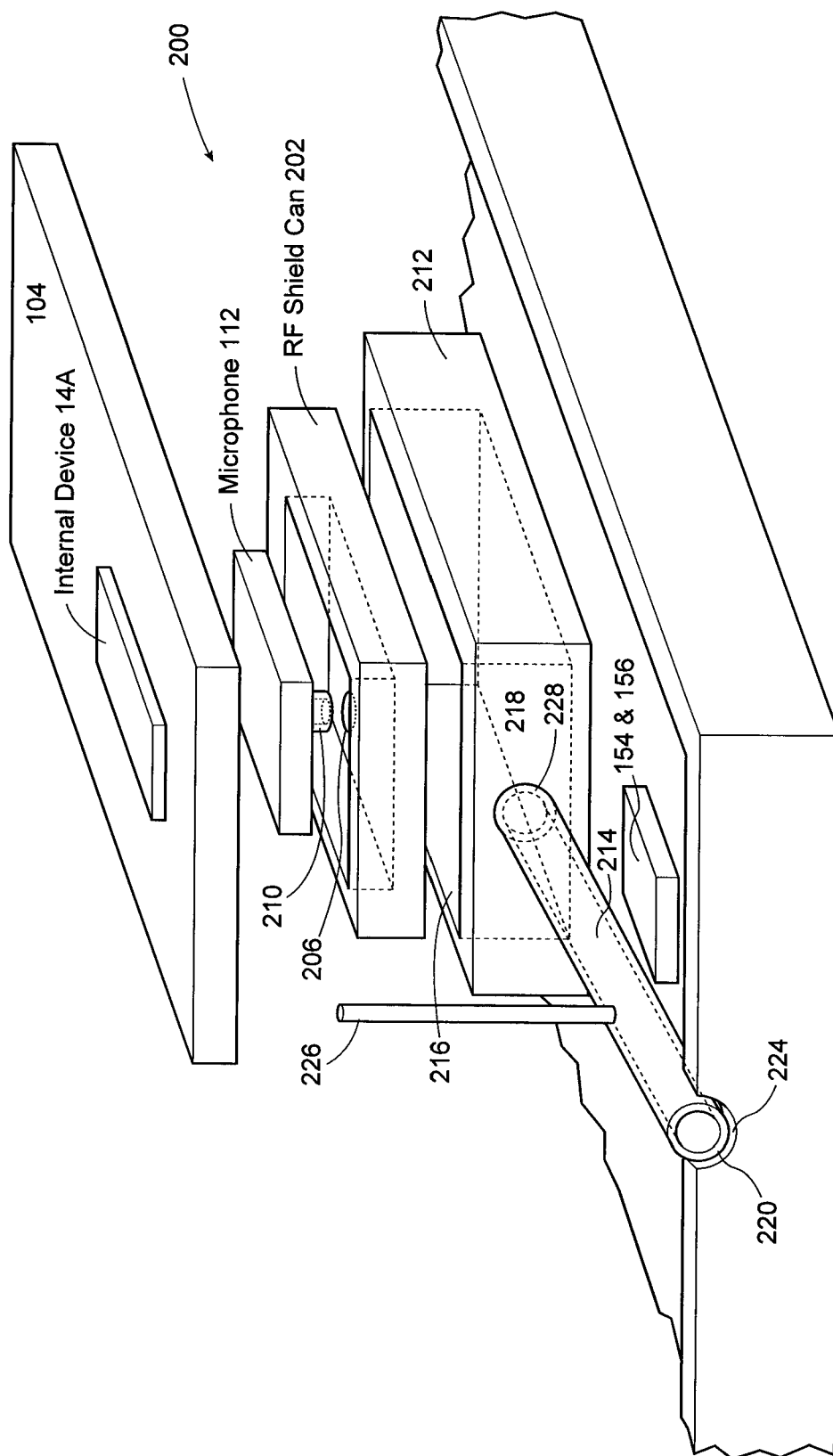
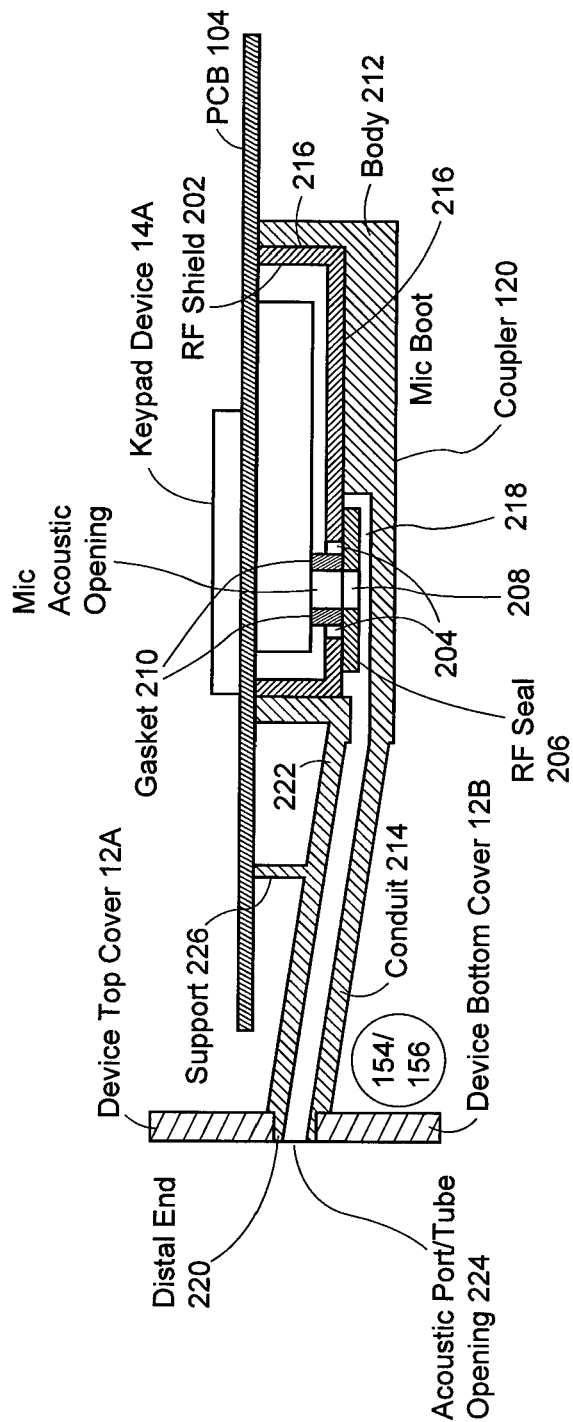


Figure 2



### Figure 3

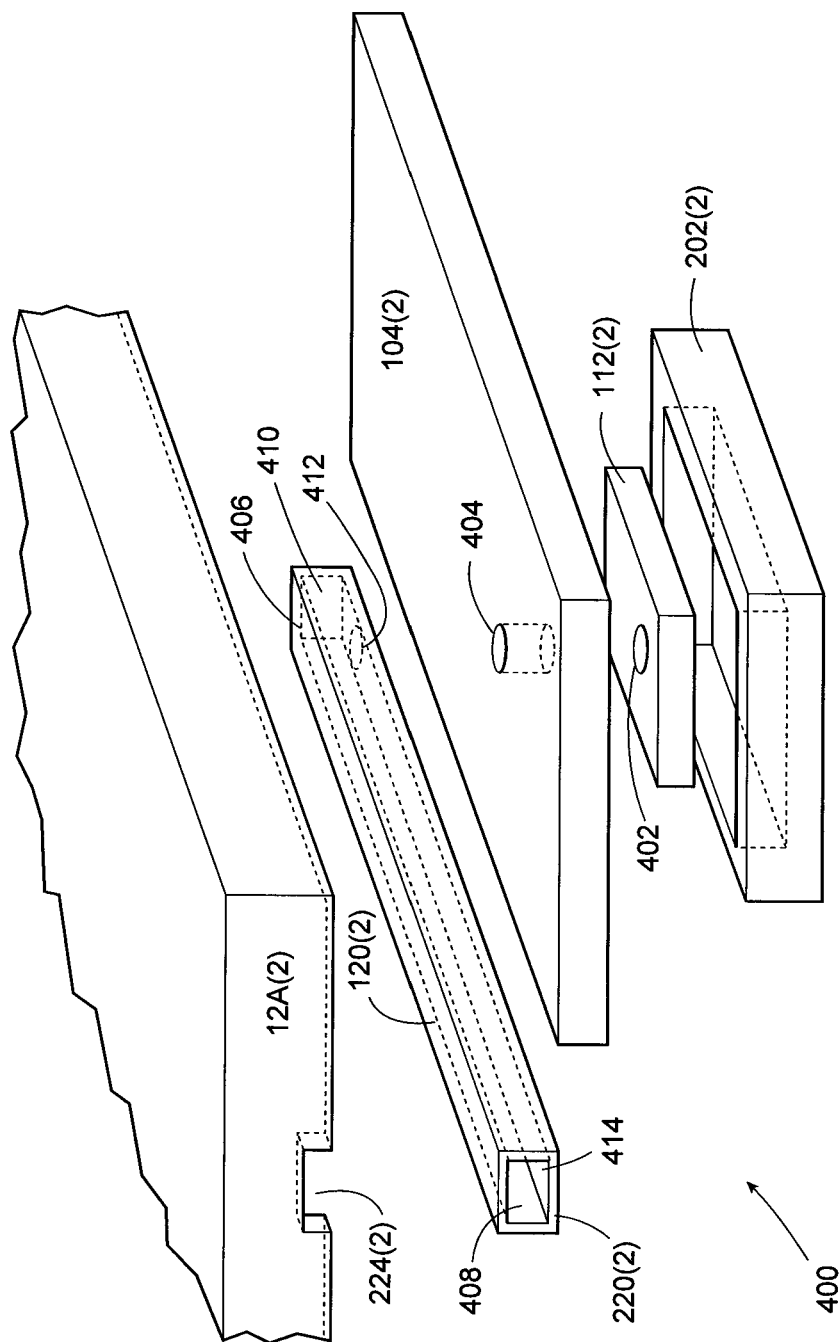


Figure 4

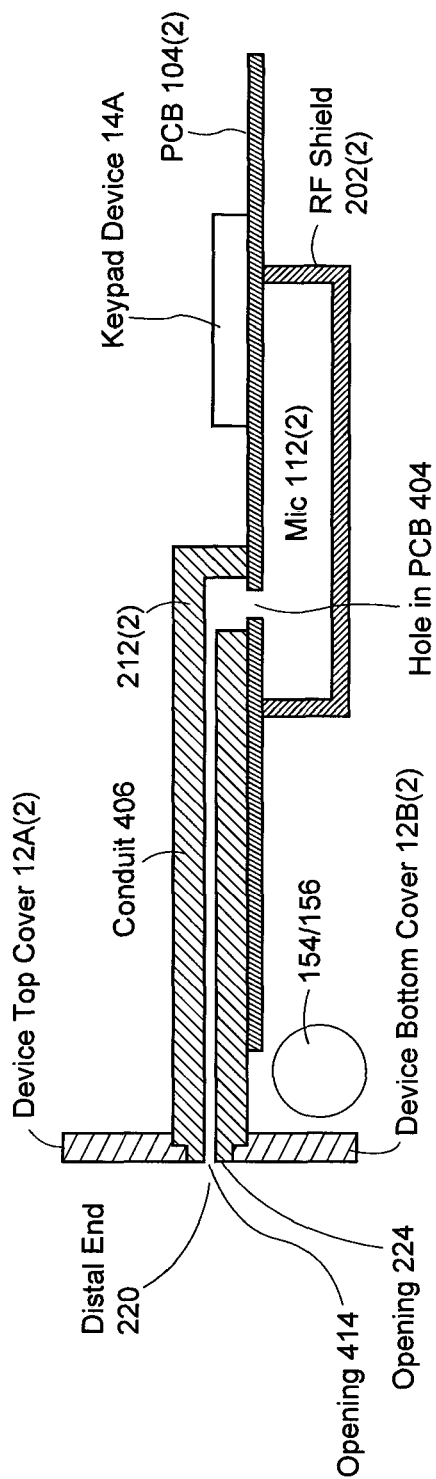


Figure 5

# COMMUNICATION DEVICE HAVING A MICROPHONE COUPLER

## RELATED APPLICATIONS

This application is a continuation application of U.S. patent application Ser. No. 13/324,511 (now U.S. Pat. No. 8,548,185) filed on Dec. 13, 2011, which is a continuation application of U.S. patent application Ser. No. 12/464,727 (now U.S. Pat. No. 8,094,856) filed on May 12, 2009, which is a continuation application of U.S. patent application Ser. No. 10/989,071 (now U.S. Pat. No. 7,548,628) filed on Nov. 16, 2004.

## FIELD OF DISCLOSURE

The disclosure relates to a voice communication device having a microphone coupler, where the coupler provides an air channel from the exterior of the device to a microphone located within the device.

## BACKGROUND

In a voice communication device, a microphone and a speaker must be provided in order to allow a user to send and receive audio signals with another compatible device used by another person.

In a typical telephone, a handset is provided which is a shaped form having two transducers, e.g. a microphone and a speaker, positioned in a well-spaced relationship. Meanwhile, portable communication devices, such as cellular phones, have smaller and smaller form factors. Locating transducers in a cellular phone is a difficult task, because there are space restrictions on potential locations for the transducers and in certain confined spaces, the location of a transducer, such as a microphone, must be sufficiently isolated from signal interference generated from other devices within the phone. As such, in some instances a microphone may need to be placed at a location which is not especially close to the associated microphone port in the housing of the phone.

There is a need for an arrangement which addresses such difficulties in the prior art.

## BRIEF DESCRIPTION OF DRAWINGS

The foregoing and other aspects of the disclosure will become more apparent from the following description of specific embodiments thereof and the accompanying drawings which illustrate, by way of example only, the principles of the disclosure. In the drawings, where like elements feature like reference numerals (and wherein individual elements bear unique alphabetical suffixes):

FIG. 1 is a block diagram of a communication device having a microphone and a microphone coupler according to an embodiment of the disclosure;

FIG. 2 is an exploded perspective view of aspects of the microphone coupler and its surrounding components of a first implementation of the device of FIG. 1;

FIG. 3 is side cross-section view of the microphone and its surrounding components of the implementation of FIG. 2;

FIG. 4 is an exploded perspective view of aspects of the microphone coupler and its surrounding components of a second implementation of the device of FIG. 1; and

FIG. 5 is side cross-section view of the microphone and its surrounding components of the implementation of FIG. 4.

# DETAILED DESCRIPTION OF AN EMBODIMENT

The description which follows, and the embodiments described therein, are provided by way of illustration of an example, or examples, of particular embodiments of the principles of the present disclosure. These examples are provided for the purposes of explanation, and not limitation, of those principles and of the disclosure. In the description, which follows, like parts are marked throughout the specification and the drawings with the same respective reference numerals.

In a first aspect, a handheld, mobile communication device is provided. The device comprises: a housing including a housing port; a microphone in the housing; circuitry in the housing and connected to the microphone; a coupler including an acoustic conduit having a first end in communication with the housing port and a second end, and a body section associated with the microphone and in communication with the second end of the acoustic conduit; and a support to brace the coupler in the housing.

In the mobile communication device, the housing may include a bottom cover and the housing port is in the bottom cover.

In the mobile communication device, the housing may include an antenna adjacent the housing port.

In the mobile communication device, the antenna may send or receive information from a voice network or a data network.

In the mobile communication device, the housing may include a voice communication subsystem in communication with the microphone and the antenna.

In the mobile communication device, the support may be connected to the acoustic conduit.

In the mobile communication device, the body section may define an acoustic chamber adjacent the second end of the acoustic conduit.

In the mobile communication device, the acoustic conduit may be plastic and the support may be plastic.

In the mobile communication device, the body section may fit around the microphone.

In the mobile communication device, the body section may include a radio frequency shield around the microphone.

In the mobile communication device, the radio frequency shield may include an aperture to allow acoustic signals to the microphone.

In the mobile communication device, the body section may include an interior cavity.

In the mobile communication device, the coupler may form an air channel to the microphone from ambient surroundings outside the housing.

In the mobile communication device, the air channel may include a sealed acoustic chamber.

In the mobile communication device, the microphone may be a silicon-based transducer.

In the mobile communication device, the acoustic conduit may have an interior cross section of approximately 4 mm<sup>2</sup>.

In the mobile communication device, the acoustic conduit may have a length of approximately 10 to 15 mm.

In a second aspect, a mobile telephone is provided, comprising: a housing forming a case with an acoustic port; an input device supported by the housing; an output device supported by the housing; a communication subsystem in the housing; a microphone in the housing; an acoustic conduit, in the housing, having a first end in communication with the acoustic port and a second end, and a body, in the housing, associated with the microphone and in communication with

the second end of the acoustic conduit; and a support to align the acoustic conduit in the housing.

In the mobile telephone, the support may extend from the acoustic conduit.

In the mobile telephone, the output device may be a display; the microphone may convert acoustic signals to electrical signals and sends the electrical signals to the communication subsystem; the communication subsystem may convert the electrical signal to a radio frequency signal and send the radio frequency signal to an antenna that is mounted in the housing, wherein the antenna is mounted in the housing; and the body may be affixed in the housing.

In another aspect, a microphone coupler for a communication device is provided. The communication device comprises a printed circuit board and a microphone mounted on a first side of the printed circuit board and the microphone has a port facing towards the printed circuit board and aligned with an opening through the printed circuit board. The coupler comprises: a conduit having an internal channel therein, a distal end, a proximal end, a first opening in the distal end connecting to the internal channel and a second opening in the proximal end connecting to the internal channel. In the coupler, the proximal end is located about the opening of the printed circuit board and the second opening is mated to the opening of the printed circuit board; and the distal end extends towards an end of the printed circuit board.

In the coupler, the conduit may be oblong in shape.

In the coupler the conduit may be attachable to the printed circuit board through at least one of a friction fit, a fixative or a weld.

In the coupler, the conduit may have a length of between approximately 10 and 15 mm.

In the coupler, the first opening may have a cross-sectional area being approximately 4 mm<sup>2</sup>.

In the coupler, the first opening may have cross-sectional dimensions of approximately 1 mm×3 mm.

In still another aspect, a microphone coupler for a microphone located within a housing of a communication device is provided. The coupler comprises a body section and a conduit. The body section is shaped to fit around the microphone. It is defined by one or more walls and within the walls an interior cavity is defined. One wall has a port in through connecting to the internal cavity. The internal cavity is defined to receive at least a portion of the microphone and to define a spaced relationship between the microphone and the body section. The conduit has an internal channel therein, a distal end, a proximate end, a first opening in the distal end connecting to the internal channel and a second opening in the proximate end connecting to the internal channel. For the conduit, the proximate end is connected to the body section and the second opening mates with the port. Further, the distal end extends towards a microphone opening in the housing.

In the microphone coupler, the proximate end of the conduit may mate with a side wall of the body section.

In the microphone coupler, the conduit and the body section may be formed as a single piece.

In the microphone coupler, the conduit may have a longitudinal length of between 10 mm and 15 mm.

In the microphone coupler, there may be a support member connected to the conduit, which is attachable to a location within the housing to provide a brace for conduit.

In the microphone coupler, the coupler is comprised of a plastic material.

In another aspect, a portable communication device for communicating signals in a wireless manner is provided. The device comprises a housing, a printed circuit board, a micro-

phone located within the housing on the printed circuit board, an antenna located at least in part within the housing and a microphone coupler for the microphone located within the housing. The coupler comprises a body section shaped to fit around the microphone and a conduit. The body section has a port through a wall of the body section and an internal cavity within the body section. The cavity is shaped to receive at least a portion of the microphone and to define a spaced relationship between the microphone and the body section. The conduit has an internal channel therein, a distal end, a proximate end, a first opening in the distal end connecting to the internal channel and a second opening in the proximate end connecting to the internal channel. In the conduit, the proximate end is connected to the body section and the port mates with the first opening. Further, the distal end extends towards a microphone opening in the housing.

In the device, the antenna may be located within the housing in a volume between the body section to the microphone.

In the device, the antenna may be located in a bottom portion of the housing.

In the device, the microphone and coupler may be located on a bottom side of the circuit board.

In the device, the conduit may span the volume and may connect the port with the microphone opening.

The device may further comprise an RF shield can for isolating the microphone from interference caused from signals associated with the antenna. The RF shield can is located between the microphone and the coupler.

The device may further comprise a support member providing a brace for the conduit, where the support member is attached to a location within the housing at one end and is attached to the conduit at another end.

The device may further comprise a gasket located about the microphone providing a channel from the microphone to outside the RF shield can.

The device may further comprise a keypad device located on a top side of the circuit board.

In another aspect, the coupler comprises only the conduit and is located on a top side of the circuit board. Further, the microphone is located on the bottom side and is in communication with the coupler through an opening in the circuit board.

In other aspects various combinations of sets and subsets of the above aspects are provided.

FIG. 1 schematically illustrates a handheld mobile communication device 10 and its components, including a housing 12, an input device (e.g. keyboard 14A or thumbwheel 14B) and an output device (a display 16), which is preferably a graphic Liquid Crystal Display (LCD), although other types of output devices may alternatively be utilized. Typically, housing 12 is a molded polycarbonate structure and may be formed via known plastic forming techniques. To assist in assembly of device 10, housing 12 typically comprises two or more pieces which fit together in a fitted arrangement to enclose the internal devices and form an exterior casing for device 10. For example, housing 12 may comprise an upper housing (12A) and a lower housing (12B). Physically for device 10, housing 12 may be elongated vertically, or may take on other sizes and shapes (including clamshell housing structures).

A processing device (a microprocessor 18) is shown schematically in FIG. 1 as coupled between keyboard 14A, thumbwheel 14B, display 16 and a series of other internal devices to device 10. For the purposes of the description, the term keypad and keyboard refers to both the exterior mechanical exposed key elements and the underlying switch and activation elements (e.g. elastomers, domes and contact regions).

The microprocessor **18** controls the operation of the display **16**, as well as the overall operation of the device **10**, in response to actuation of keys on the keyboard **14A** or thumb-wheel **14B** by a user. Exemplary microprocessors for microprocessor **18** include Data 950 (trade-mark) series microprocessors and the 6200 series microprocessor, both available from Intel Corporation.

In addition to the microprocessor **18**, other internal devices of the device **10** are shown schematically in FIG. 1. These devices include: a communication subsystem **100**, a short-range communication subsystem **102**, a set of auxiliary I/O devices **106**, a serial port **108**, a speaker **110** and a microphone **112**. Memory for device **10** is provided in flash memory **116** and Random Access Memory (RAM) **118**. Internal devices are enclosed within housing **12** and typically are either mounted onto a printed circuit board (PCB), affixed to an interior part of the housing or suspended by some means within housing **12**. Microphone coupler **120** provides an acoustic chamber connecting microphone **112** from within device **10** to an opening (opening **224**, FIG. 2) in the housing, thereby providing an air channel for microphone **112** to the ambient exterior surroundings of device **10**. Aside from designed openings in coupler **120**, preferably, coupler **120** provides a sealed, or mostly sealed, acoustic chamber.

The device **10** is preferably a two-way radio frequency (RF) communication device having voice and data communication capabilities. In addition, device **10** preferably has the capability to communicate with other computer systems via the Internet.

Operating system software executed by the microprocessor **18** is preferably stored in a computer readable medium, such as flash memory **116**, but may be stored in other types of memory devices, such as read only memory (ROM) or similar storage element. In addition, system software, specific device applications, or parts thereof, may be temporarily loaded into a volatile store, such as RAM **118**. Communication signals received by the mobile device may also be stored to RAM **118**.

Microprocessor **18**, in addition to its operating system functions, enables execution of software applications on device **10**. A set of software applications that control basic device operations, such as a voice communication module **130A** and a data communication module **130B**, may be installed on the device **10** during manufacture or downloaded thereafter. Cell mapping module **130C** may also be installed on device **10** during manufacture. As well, additional software modules, illustrated as another software module **130N**, which may be, for instance, a personal information manager (PIM) application, may be installed during manufacture or downloaded thereafter into device **10**. PIM application is preferably capable of organizing and managing data items, such as e-mail messages, calendar events, voice mail messages, appointments, and task items. PIM application is also preferably capable of sending and receiving data items via a wireless network **140**.

Communication functions, including data and voice communications, are performed through the communication subsystem **100**, and possibly through the short-range communication subsystem **102**. Communication subsystem **100** includes receiver **150**, transmitter **152** and one or more antennae, illustrated as receive antenna **154** and transmit antenna **156**. In addition, communication subsystem **100** also includes processing module, such as digital signal processor (DSP) **158** and local oscillators (LOs) **160**. The specific design and implementation of communication subsystem **100** is dependent upon the communication network in which device **10** is intended to operate. For example, communication subsystem

**100** of the device **10** may be designed to operate with the Mobitex (trade-mark), DataTAC (trade-mark) or General Packet Radio Service (GPRS) mobile data communication networks and also designed to operate with any of a variety of voice communication networks, such as Advanced Mobile Phone Service (AMPS), Time Division Multiple Access (TDMA), Code Division Multiple Access CDMA, Personal Communication Service (PCS), Global System for Mobile Communication (GSM), etc. Other types of data and voice networks, both separate and integrated, may also be utilized with device **10**. It will be appreciated that some signals received and transmitted through the subsystem **100** may provide interfering signals with other components in device **10**, such as microphone **112**.

Network access requirements vary depending upon the type of communication system which can communicate with device **10**. For example, in the Mobitex (trade-mark) and DataTAC (trade-mark) networks, mobile devices are registered on the network using a unique Personal Identification Number (PIN) associated with each device. In GPRS networks, however, network access is associated with a subscriber or user of a device. A GPRS device therefore requires a subscriber identity module, commonly referred to as a Subscriber Identity Module (SIM) card, in order to operate on a GPRS network.

When required network registration or activation procedures have been completed, device **10** may send and receive communication signals over communication network **140**. Signals received from communication network **140** by the receive antenna **154** are routed to receiver **150**, which provides for signal amplification, frequency down conversion, filtering, channel selection, etc., and may also provide analog to digital conversion. Analog-to-digital conversion of received signals allows the DSP **158** to perform more complex communication functions, such as signal demodulation and decoding. In a similar manner, signals to be transmitted to network **140** are processed (e.g., modulated and encoded) by DSP **158** and are then provided to transmitter **152** for digital to analog conversion, frequency up conversion, filtering, amplification and transmission to communication network **140** (or networks) via the transmit antenna **156**.

In addition to processing communication signals, DSP **158** provides for control of receiver **150** and transmitter **152**. For example, gains applied to communication signals in receiver **150** and transmitter **152** may be adaptively controlled through automatic gain control algorithms implemented in DSP **158**.

In a data communication mode, a received signal, such as a text message or web page download, is processed by the communication subsystem **100** and is input to microprocessor **18**. The received signal is then further processed by microprocessor **18** for an output to the display **16**, or alternatively to some other auxiliary I/O devices **106**. A device user may also compose data items, such as e-mail messages, using keyboard (keypad) **14A**, thumb-wheel **14B** and/or some other auxiliary I/O device **106**, such as a touchpad, a rocker switch or some other type of input device. The composed data items may then be transmitted over communication network **140** via communication subsystem **100**.

In a voice communication mode, overall operation of device **10** is substantially similar to the data communication mode, except that received signals are output to speaker **110**, and received audio signals are provided to microphone **112** for further conversion into an electrical signal and further processing by device **10**. Microphone **112** is preferably a silicon-based transducer which can be mounted to PCB **104** (shown in FIG. 2).

Short-range communication subsystem **102** enables communication between device **10** and other proximate systems or devices, which need not necessarily be similar devices. For example, the short-range communication subsystem may include an infrared device and associated circuits and components, or a Bluetooth (trade-mark) communication module to provide for communication with similarly-enabled systems and devices.

Powering the entire electronics of the mobile handheld communication device is power source **170**. Preferably, the power source **170** includes one or more batteries. More preferably, the power source **170** is a single battery pack, especially a rechargeable battery pack. Power switch **172** provides a separate on/off switch for device **10**.

Referring to FIGS. **2** and **3**, further detail on aspects of housing **12** and internal devices of device **10**. First, PCB **104** provides a substrate for mounting and supporting the internal devices on both of its top and bottom sides and provides some electrical circuitry for the devices, as defined by etchings within the layers of plastic and copper. As such, devices can be more densely packed thereon, thereby reducing the size of PCB **104**. PCB **104** is securely mountable within housing **12**, typically via screws. PCB **104** is a generally planar sandwich of layers of plastic (or FR4) and copper.

Certain physical and operational restrictions may affect the location of devices on PCB **104** and to their placement on a particular side thereof. For example, a conventional industrial exterior design of device **10** has keypads on its top surface, thereby requiring that the electrical components relating to the keypad be placed on the top side of PCB **104**. Similarly, microphone **112** can be sensitive to interference signals from antenna **154** and **156** and display **16**. As such, it is preferable to locate microphone **112** as far away as possible from such devices. In one design layout, at least one of antennae **154** and **156** is located on the bottom side of circuit board **104** in the bottom part of device **10**. To assist in isolating microphone **112** from interference from such antennae **154** and **156**, microphone **112** is located in a central region of PCB **104**. However, since one or more elements of keypad **14A** (e.g. dome and contact elements) is located on the top side of the central region of PCB **104**, microphone **112** is located on the bottom side of the central region of PCB **104**. This positioning also provides more efficient use of the total available surface area of PCB **104**.

To further assist in shielding microphone **112**, radio frequency (RF) shield can **202** is provided to cover microphone **112** on PCB **104**. Shield can **202** provides a Faraday shield to isolate microphone **112** from electromagnetic interference. Such interference may originate from signals received and generated by either antenna **154** or **156**. Shield can **202** has aperture **204** therein to allow audio signals entering opening **224** to ultimately enter shield can **202** and be provided to microphone **112**. Aperture **204** is covered in part by RF seal **206** which is a shaped, flat piece, larger than aperture **204**. Seal **206** has an aperture **208** located therein. RF seal **206** is located over aperture **204**, with aperture **208** aligned with aperture **204**, thereby defining an opening in RF shield can **202**. Shield can **202** and RF seal **206** are preferably made of metal and are shaped to completely enclose microphone **112**, but for aperture **204**, when microphone **112** is mounted onto PCB **104**. Shield can **202** is oblong in shape, but any suitable shape may be used. RF seal **206** is fixed to shield can **202** by an appropriate fixative, such as double sided tape, adhesive or weld. Alternative embodiments may dispense with having a shield can.

Gasket **210** is an annular ring and is dimensioned to fit within aperture **204** and is comprised of a compressible mate-

rial and to rest against the acoustic receiving part (e.g. the microphone opening) of microphone **112**. Gasket **210** provides an acoustic conduit for audio signals received at aperture **208**, allowing such signals to reach microphone **112**. In the embodiment, it is compressible by approximately 40%. Seal **206** is positioned such that its upper end rests against gasket **210** and its lower end extends downward to the top surface of the bottom of shield can **206**. Other materials may be used if other compression characteristics are required. Alternative embodiments may dispense with having a gasket. Aperture **204** is dimensioned to be able to accommodate gasket **210** within and still provide an appropriate RF shield for microphone **112** when seal **206** is in electrical and physical contact with can **202**. It is not necessary that aperture **204** provides a tight fit around gasket **210**.

In the embodiment, microphone **112** and shield can **202** are components which can be surface mounted to PCB **104**. However, during an SMT soldering process, there may be difficulties in simultaneously mounting can **202** and gasket **210** to PCB **104**. As such, shield can **202** is provided with aperture **204**. In a second stage of assembly of components onto PCB **104** following the SMT process, gasket **210** is inserted in place and RF seal **206** is placed and fixed over aperture **204**.

Microphone coupler **120** is a shaped body which encloses RF shield can **202** and provides another acoustic conduit to carry audio signals from external sources around device **10** to aperture **208** (and ultimately again, to microphone **112**). Coupler **120** comprises a body section **212** and a conduit **214**. Body section **212** is defined by a series of walls and within the walls an interior cavity **216** is defined and shaped to provide a snug fit around a part (or even all) of RF shield can **202**. Interior cavity **216** defines air space **218** immediately below aperture **208** to enable audio signals to traverse to aperture **208**. Conduit **214** is generally an elongated tube having distal end **220**, proximal end **222** and openings at each end. Distal end **220** mates with opening **224** in housing **12**. Proximal end and its opening mates with a port in one of the walls of body section **212**. One purpose of conduit **214** is to provide an acoustic chamber to connect microphone **112** to opening **224** to allow microphone **112** to receive audio signals arriving at the opening with minimal (or tolerable) loss in the strength of the audio signals. The opening at proximal end **222** connects with interior cavity **218**. As such, a continual air channel is provided from outside of the device to opening **224** through conduit **214**, then through interior cavity **218**, then through apertures **204** and **208** and finally to microphone **112**. One embodiment has conduit **214** having a length of between approximately 10 to 15 mm and the cross-sectional area of the conduit being approximately 4 mm<sup>2</sup>. Other cross sectional dimensions can be approximately 1 mm×3 mm. Other shapes for the cross section may also be provided. Other longer and shorter lengths and cross-sectional dimensions may be used. In the embodiment, the acoustic chamber defined by conduit **214** passes through a volume of space in which one or more of antennae **154** and **156** are located. As such, if an antenna or another device which interferes with the operation of microphone **112** is placed in a volume of space which audio signals must pass through to reach microphone **112** from opening **224**, conduit **214** provides at least two functions. First, conduit **214** allows microphone **112** to be placed in a spaced relationship to the antenna (or other device) such that the interference caused by the antenna (or other device) is reduced to a tolerable level. Second conduit **214** carries such audio signals to microphone **112**.

Support **226** is generally a beam and extends upwardly from conduit **214** to contact PCB **104**, thereby providing a

brace for conduit **214** to PCB **104**. The specific location of support **226** on conduit **214** may be in any suitable location. Further the specific contact point on PCB **104** may also be any suitable location thereon. Further still, the shape and dimensions of support **226** may be almost defined to meet any requirements or limitations, including structural, spacing, support and material requirements. Coupler **120** may be mounted to PCB **104** using a fixative, such as double sided adhesive tape or an adhesive. It will be appreciated that with coupler **120**, microphone **112** may be placed in more locations within device **10** (e.g. more locations which are further away from signal interfering sources, such as antenna **154** and **156** and display **16**) and while providing a channel to allow audio signals to be carried from microphone opening **224** in housing **12** to the microphone without serious degradation in signal strength. In other embodiments, support **226** may not be required or other structural supports to other interior locations within housing **12** may be provided.

In one embodiment body section **212** and conduit **214** are formed as a single unit. In other embodiments, conduit **214** is attachable to body section **212** through an appropriate means, including a friction fit, a fixative (such as tape or glue), a weld, a thread and screw mechanism, a “snap” fit or other connection mechanisms known in the art.

Also, other shapes and dimensions for components of coupler **120** may be used in other embodiments. Still further, coupler **120** may be shaped to provide a snug fit around shield can **202** thereby reducing the need for fixing coupler **120** to PCB **104**. The physical profile of coupler **120** may be designed such that bends and turns taken by any audio signals passing through coupler **120** are not degraded to an extent where the signals are not strong enough for microphone **112** to operate effectively.

Preferably coupler **120** is made of an elastic, plastic or a flexible material, such as rubber, silicone or urethane. Alternatively, coupler **120** may be formed in part or in whole by any one or a combination of structures formed in PCB **104**, housing **12**, upper housing **12A** and lower housing **12B**. Conduit **214** is shaped, sized and angled to mate with an opening (or port) in a wall of coupler **120** which connects to interior cavity **218**. As shown, conduit **214** extends slightly upwardly from the lower region of body section **222** upwardly to opening **224**. In other embodiments, opening **224** may be located on the top, side or bottom of housing **12**. For example, if opening **224** were located more towards the rear of the bottom of housing **12** (as is shown), then conduit **214** extends directly downward from body section **222** to the location of opening **224**.

It will be appreciated that in other embodiments, the location of the components for the microphone **112** and coupler **120** may be placed on the top side of PCB **104**. Also, depending on the location of antennae **154** and **156**, the shape of body section **212** and conduit **214** may be designed to accommodate physical, material and signal isolation requirements to meet the environment of the locations of the relevant components. For example, in another embodiment, shield can **202** and seal **206** may not be used and coupler **120** forms a fit around microphone **112** alone. The fit may be a tight fit.

Referring to FIGS. **4** and **5** another embodiment is shown. As there are similarities between selected components in FIGS. **4** and **5** and components in FIGS. **2** and **3**, where a like component is shown in FIGS. **4** and **5**, its reference numeral is the same as provided in FIGS. **2** and **3**, but a (2) suffix is added.

In FIGS. **4** and **5**, view **400** provides an exploded view of elements of another embodiment. Therein, microphone **112** (2) is a “zero height” microphone. An exemplary zero-height

microphone is an SMT device and is available from Knowles Acoustics of Itasca, Ill., U.S.A. In this implementation, microphone **112**(2) receives audio signals to microphone port **402** which is on the surface mount side (i.e. the underside) of microphone **112**(2). As such, in order to provide access for audio signals to reach the acoustic port of microphone **112**(2), opening **404** is provided through PCB **104**(2) provides a channel from the top side to the bottom side of PCB **104**(2). Opening **404** is located on PCB **104**(2) where the acoustic port **402** of microphone **112**(2) will be located when permanently mounted to PCB **104**(2). Opening **404** may be formed as a via opening and may be lined or not.

To further assist in shielding microphone **112**(2), radio frequency (RF) shield can **202**(2) is provided to cover microphone **112**(2) on PCB **104**(2). Shield can **202**(2) provides a Faraday shield to isolate microphone **112**(2) from electromagnetic interference. Such interference may originate from signals received and generated by either antenna **154** or **156**. Here, shield can **202**(2) is preferably made of metal and is shaped to completely enclose microphone **112**(2) when microphone **112**(2) is mounted onto PCB **104**(2). Shield can **202**(2) is oblong in shape, but any suitable shape may be used. Alternative embodiments may dispense with having a shield can. In the embodiment, microphone **112**(2) and shield can **202**(2) are components which can be surface mounted to PCB **104**(2).

Coupler **120**(2) comprises conduit **406**. Conduit **406** is generally an elongated tube having distal end **408**, proximal end **410** and openings at each end (**414** and **412**). Distal end **408** mates with opening **224**(2) in housing **12**. Proximal end **410** has opening **412** on its bottom side which mates with opening **404**. One purpose of opening **404** is to provide an acoustic chamber to connect microphone **112**(2) to opening **412** to allow microphone **112**(2) to receive audio signals arriving at the opening with minimal (or tolerable) loss in the strength of the audio signals. As such, a continual air channel is provided from outside of the device to opening **414**, through conduit **406**, through opening **412** and opening **404** and finally to microphone **112**(2). One embodiment has conduit **406** having a length of between approximately 10 to 15 mm. Its interior cross section dimensions may be similar to dimensions noted earlier. Other longer and shorter lengths may be used. In the embodiment, the acoustic chamber defined by conduit **406** passes through a volume of space in which one or more of antennae **154** and **156** are located. As such, if an antenna or another device which interferes with the operation of microphone **112**(2) is placed in a volume of space which audio signals must pass through to reach microphone **112**(2) from opening **224**(2), conduit **406** provides at least two functions. First, conduit **406** allows microphone **112**(2) to be placed in a spaced relationship to the antenna (or other device) such that the interference caused by the antenna (or other device) is reduced to a tolerable level.

Coupler **120**(2) may be mounted to PCB **104**(2) using a fixative, such as double sided adhesive tape or an adhesive. It will be appreciated that with coupler **120**(2), microphone **112**(2) may be placed in more locations within device **10** (e.g. more locations which are further away from signal interfering sources, such as antenna **154** and **156** and display **16**) and while providing a channel to allow audio signals to be carried from microphone opening **224**(2) in housing **12** to the microphone without serious degradation in signal strength.

In one embodiment conduit **406** is formed as a single unit. In other embodiments, conduit **406** may be formed in part or in total by one or more of housing **12** and PCB **104**(2). Conduit **406** is attachable PCB **104**(2) through an appropriate

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means, including a friction fit, a fixative (such as tape or glue), a weld, a “snap” fit or other connection mechanisms known in the art.

Also, other shapes and dimensions for coupler 120(2) may be used in other embodiments. Still further, coupler 120(2) may be shaped to provide a snug fit around other components on its path on PCB 104(2). The physical profile of coupler 120(2) may be designed such that bends and turns taken by any audio signals passing through coupler 120(2) are not degraded to an extent where the signals are not strong enough for microphone 112(2) to operate effectively.

Preferably coupler 120(2) is made of an elastic, plastic or a flexible material, such as rubber, silicone or urethane. Conduit 406 is shaped, sized and angled to mate with an opening 404 (or another port) in circuit board 104(2). In other embodiments, opening 224(2) may be located on the top, side or bottom of housing 12. For example, if opening 224(2) were located more towards the rear of the bottom of housing 12 (as is shown), then conduit 406 may either extend past PCB 104(2) then extend directly to the location of opening 224(2) or through PCB 104(2) through an appropriate opening and then towards opening 224(2).

In other embodiments, depending on the location of port 402, coupler 120(2) may be located on a same side of PCB 104(2) as microphone 112(2) (top or bottom). Also, depending on the location of antennae 154 and 156, the shape of conduit 406 may be designed to accommodate physical, material and signal isolation requirements to meet the environment of the locations of the relevant components. For example, in another embodiment, shield can 202(2) may not be used.

Although the disclosure has been described with reference to certain specific embodiments, various modifications thereof will be apparent to those skilled in the art without departing from the scope of the disclosure as outlined in the claims appended hereto.

The invention claimed is:

1. A handheld, mobile communication device comprising:
  - a housing including a housing port;
  - a printed circuit board (PCB);
  - a microphone on the PCB in the housing;
  - circuitry in the housing and connected to the microphone;
  - a coupler including:
    - an acoustic conduit having a first end in communication with the housing port and a second end, and
    - a body section covering the microphone, contacting the PCB and being in communication with the second end of the acoustic conduit; and
  - a support connected to the acoustic channel to brace the coupler in the housing.
2. The mobile communication device of claim 1, wherein the housing includes a bottom cover and the housing port is in the bottom cover.
3. The mobile communication device of claim 1, wherein the housing includes an antenna adjacent the housing port.
4. The mobile communication device of claim 3, wherein the antenna can send or receive information from a voice network or a data network.

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5. The mobile communication device of claim 3, wherein the housing includes a voice communication subsystem in communication with the microphone and the antenna.

6. The mobile communication device of claim 1, wherein the body section defines an acoustic chamber adjacent the second end of the acoustic conduit.

7. The mobile communication device of claim 1, wherein the acoustic conduit is plastic and the support is plastic.

8. The mobile communication device of claim 1, wherein the body section covers the sides and top of the microphone.

9. The mobile communication device of claim 1, wherein the body section includes a radio frequency shield around the microphone.

10. The mobile communication device of claim 9, wherein the radio frequency shield includes an aperture to allow acoustic signals to the microphone.

11. The mobile communication device of claim 1, wherein the body section includes an interior cavity.

12. The mobile communication device of claim 1, wherein the coupler forms an air channel to the microphone from ambient surroundings outside the housing.

13. The mobile communication device of claim 12, wherein the air channel includes a sealed acoustic chamber.

14. The mobile communication device of claim 1, wherein the microphone is a silicon-based transducer.

15. The mobile communication device of claim 1, wherein the acoustic conduit has an interior cross section of approximately 4 mm<sup>2</sup>.

16. The mobile communication device of claim 1, wherein the acoustic conduit has a length of approximately 10 to 15 mm.

17. A mobile telephone comprising:

- a housing forming a case with an acoustic port;
- a printed circuit board (PCB);
- an input device and supported by the housing;
- an output device supported by the housing;
- a communication subsystem in the housing;
- a microphone located on the PCB and located in the housing;
- an acoustic conduit, in the housing, having
  - a first end in communication with the acoustic port and
  - a second end, and
- a body, in the housing, covering the microphone, contacting the PCB and being in communication with the second end of the acoustic conduit; and
- a support extending from the acoustic conduit and aligning the acoustic conduit in the housing.

18. The mobile telephone of claim 17, wherein:

- the output device is a display;
- the microphone converts acoustic signals to electrical signals and sends the electrical signals to the communication subsystem;
- the communication subsystem converts the electrical signal to a radio frequency signal and send the radio frequency signal to an antenna that is mounted in the housing, wherein the antenna is mounted in the housing; and
- the body is affixed in the housing.

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